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FERMENTED PICKLES

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MANY American housewives put up their own pickles, particularly when the home garden furnishes a large supply of cucumbers or other products adapted to pickling purposes. This bulletin contains a brief description of the processes involved in pickling, and gives the methods by which it is believed that the standard varieties of pickles can be prepared successfully in the home.

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INTRODUCTION.

The cucumber is one of the oldest of the garden vegetables. Taking its origin in the Far East, probably in India, some 3,000 years ago, it has gradually spread, until to-day it is found under cultivation in some form in practically every country in the civilized world.

As a fresh vegetable the cucumber has a most refreshing and appetizing flavor, and is held in high esteem by the great majority of people. It is, however, in the making of pickles that the cucumber finds its chief value, being, above all other vegetables, well adapted to this purpose. As a result, there are few homes in this country in which cucumber pickles in some form do not find a place in the dietary.

The great demand for pickles among all classes early led to their production on a commercial basis, and this now constitutes a large and growing industry in which much capital is invested and many people given employment. The introduction of salting stations in those sections where cucumbers can be grown to good advantage has resulted in stabilizing the supply. At these stations cucumbers are cured in large quantities and held in reserve. Consequently the markets are fairly well supplied at all times with pickles, regardless of a failure of the crop in any season or in any locality.

Many housewives, however, prefer to make their own pickles, a commendable practice where the home garden affords a liberal supply

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of cucumbers. This bulletin deals only with the home production of pickles. It presents in the simplest way possible the essential processes involved, as well as the methods by which it is believed the standard and well-known varieties of pickles can be successfully prepared in the home.

CULTIVATION OF THE CUCUMBER.

Although normally a lover of subtropical conditions, the cucumber can be grown successfully in almost any part of the United States, provided care is taken to avoid exposure to frost. The best soil for its growth is a sandy or clay loam, but it can be grown on practically any soil that will produce good corn or potatoes. The best results, however, are obtained only when the soil is well fertilized, well-rotted stable manure being as good as anything for this purpose, although commercial fertilizers are often used to good advantage.

In gathering the crop, from one-eighth to one-fourth inch of the stem should be left on the cucumber, and care should be taken to avoid bruising it.

Certain varieties of cucumbers produce fruits which because of their shape, firmness, or keeping quality are better adapted to pickling purposes than others. When this is the end in view, these varieties should be selected in preference to the more rapid-growing and less resistant varieties of the market type. Among the best known of the pickling varieties are the Chicago Pickling, Boston Pickling, and Snow's Perfection. Cucumbers of practically all varieties, sizes, and shapes, however, may be utilized for pickling. This fact should be kept in mind in those localities where cucumbers are largely grown for the market, and, in fact, by all truck gardeners who raise this crop.

Complete information on the cultivation of the cucumber and the prevention of the diseases and enemies which attack it may be obtained from the following publications issued by the United States Department of Agriculture:

Farmers' Bulletin 254, Cucumbers, by L. C. Corbett.

Farmers' Bulletin 460, Frames as a Factor in Truck Growing, by W. R. Beattie.

Farmers' Bulletin 856, Control of Disease and Insect Enemies of the Home Vegetable Garden, by W. A. Orton and F. H. Chittenden.

Farmers' Bulletin 934, Home Gardening in the South, by H. C. Thompson.

Farmers' Bulletin 937, The Farm Garden in the North, by James H. Beattie.

Farmers' Bulletin 1038, The Striped Cucumber Beetle and Its Control, by F. H. Chittenden.

Farmers' Bulletin 1044, The City Home Garden, by W. R. Beattie.

Department Bulletin 727, Anthracnose of Cucurbits, by M. W. Gardner.

Department Bulletin 828, Bacterial Wilt of Cucurbits, by Frederick V. Rand and Ella M. A. Enslow.

KEEPING CUCUMBERS.

Whenever cucumbers are grown in such quantities that they do not find ready sale in the markets as a fresh vegetable, they should be placed at once in brine and converted into either salt or dill pickles. The method of doing this is very simple, entailing but little expense aside from the cost of the barrels used as containers. After being cured they can be kept as long as desired or until it becomes possible to sell them to good advantage, either in local markets or to pickle manufacturers. Thus the grower is protected against a loss by overproduction or from inability to speedily market a crop which spoils readily, and at the same time the pickle market has the benefit of a more steady and ample supply.

FERMENTATION OF CUCUMBERS.

The proper curing of cucumbers for the production of pickles is accomplished by a lactic fermentation in brine. The use of brine is necessary for two reasons: (1) By the osmotic force which it furnishes the juice of the cucumbers is withdrawn to form part of the brine. Brine also causes a hardening or firmness of the cucumber tissue. (2) The presence of salt checks the action of spoilage organisms. At the beginning of a fermentation, before sufficient acid has been formed, and later when the amount of acid has decreased, these organisms probably would attack and break down the cucumber tissue.

Cucumbers contain approximately 90 per cent of water. This water, which is extracted by the osmotic action of the brine, includes the fermentable sugar, one of the constituents of the cucumber. The sugar content of cucumbers varies from 0.5 to 2.5 per cent, depending upon the variety, and upon soil and climatic conditions. Usually it is sufficient to afford nourishment for the growth of the acid-forming bacteria, as a result of the growth of which it is split up, to form lactic and probably, to some extent, certain volatile acids. By its reaction upon the cellular structure of the cucumber the acid brine thus formed brings about those changes in color, taste, and texture which are recognized as constituting the pickled state. In other words, the cucumber ceases to be a cucumber and becomes a pickle.

As the large water content of cucumbers reduces materially the salt concentration of any brine in which they are fermented, it is necessary to add an excess of salt at the beginning of a fermentation, in the proportion of 1 pound for every 10 pounds of cucumbers fermented.

The active stage of a cucumber fermentation continues for a period of from 10 to 30 days, depending largely upon the temperature at which it is conducted. As determined by the optimum requirement

of the essential organisms, the most favorable temperature is approximately 86° F.

Practically all the sugar withdrawn from the cucumbers is utilized during the stage of active fermentation, at the end of which period the brine reaches its highest degree of acidity. During this period the salt concentration should not be materially increased, for although the lactic bacteria are fairly tolerant of salt, there is a limit to their tolerance. The addition of a large amount of salt at this time would reduce their acid-forming power just when this is essential to a successful fermentation. Salt, therefore, should be added gradually over a period of weeks. From one to two months is necessary for the complete curing of pickles. This is indicated by an increased firmness in texture, a greater degree of translucency, and a change in color from a pale green to a dark or olive green. These changes are uniform throughout the perfectly cured specimen. So long as any portion of a pickle presents a whitish or opaque appearance it can not be said to be perfectly cured.

EQUIPMENT AND SUPPLIES FOR BRINING AND PICKLING.

For the fermentation of vegetables in the home, stone jars are the most convenient and desirable receptacles. Stoneware is much more easily kept clean, and tends to absorb objectionable odors and flavors to a much smaller degree than wood. For purposes of fermentation, only the straight-sided, open-topped form of jar should be used. These can be obtained in almost any size desired, from 1 up to 20 gallons. As a rule, those holding 4 or 6 gallons are the most desirable. When larger quantities of food are to be packed kegs or barrels may be used, but only after they have been thoroughly washed, or possibly charred, in order to remove any undesirable flavors or odors which might be imparted to the foods packed in them. Undesirable flavors may be removed also from barrels by the use of solutions of caustic soda or potash. When strong lye is employed for this purpose it should be allowed to remain in the barrel for several days, after which the barrel is thoroughly soaked and washed with hot water until the alkali is removed. Wide-mouthed bottles or glass jars may be used when very small quantities of food are to be fermented or salted.

For covers, round boards, about 1 inch thick, are the most desirable. These can be made of any kind of wood except yellow or pitch pine, which would impart undesirable flavors to the vegetables. Covers should be from 1 to 2 inches less in diameter than the inside of the jar, so that they may be removed easily. Board covers are greatly improved by first dipping them in hot paraffin and then

burning them over with a flame. In this way the pores of the wood are filled and the covers can be kept clean comparatively easily. For small containers, heavy plates of suitable size may be used instead of boards, if preferred.

After packing the material in the jar it is often desirable to cover it with a clean white cloth. Cheesecloth or muslin answers this purpose best. Two or three thicknesses of cheesecloth, cut in circular form and about 6 inches larger in diameter than the inside of the jar, afford a suitable covering. Sometimes grape, beet, or cabbage leaves are used for this purpose. Grape leaves make a good covering for dill pickles, and cabbage leaves for sauerkraut.

In all cases where vegetables fermented in a weak brine are to be kept for any length of time, it is necessary to exclude air by sealing with paraffin, beeswax, or oil, to prevent spoilage. Paraffin is cheaper than beeswax and oil, and probably preferable. It should be poured over the surface while hot in quantities sufficient to make, when cooled, a solid coating about $\frac{1}{2}$ inch thick. This will effectually seal the jar, excluding the air and anything which might contaminate the contents. In packing vegetables for fermentation it is desirable that sufficient weight be placed on the cover to make the brine come up to but not over the cover. It is then necessary that only the portion of the surface around the cover be sealed with paraffin. Paraffin has the further advantage of being easily handled and readily separated from the fermented vegetables when they are removed from the container. If it becomes dirty, the dirt may be removed by first heating the paraffin to a high temperature and then straining it through several thicknesses of cheesecloth. In this way it can be used over again. It should not be applied until active fermentation has ceased, as the formation of gas below the layer might break the seal. In this event it would be necessary to remove it, heat it again, and replace it. It is also to be borne in mind that paraffin may be attacked by vermin, so that when it is used as a seal provision should be made to prevent such attacks. When jars are used this is accomplished by means of the lids.

Almost anything which furnishes the required amount of pressure will serve as a weight to hold down the mass in a jar or keg. Clean stones (except limestone) and bricks are effective.

A pair of kitchen scales and suitable vessels for determining liquid measure are, of course, an essential part of the equipment for bringing and pickling.

Fine table salt is not necessary, nor in fact desirable, for salting vegetables or making up brine. What is known as common fine salt, usually sold in bulk at about 2 cents a pound, or even a coarser salt, such as is used in freezing ice cream, is better adapted to this purpose. It is important, however, that the salt should be as nearly as

possible a pure sodium chlorid. Chemical impurities should not exceed 1 per cent. If present in larger amounts, they may interfere seriously with the success of a fermentation.

Spices are used to some extent in the production of nearly all kinds of pickles, chiefly, however, in making sweet, mixed, and dill pickles. Various combinations of spices are used, depending upon the kind of pickles to be made and also upon the flavor desired. The following whole spices are used in pickling:

Peppers, black and	Caraway.	Bay leaves.
cayenne.	Dill herb.	Coriander.
Cloves.	Mustard, yellow.	Turmeric.
Cinnamon.	Allspice.	
Celery seed.	Cardamom.	

Ginger and horse-radish root are also sometimes used. Any of these spices may be purchased in bulk and mixed as desired. Mixed whole spices, specially prepared for pickling purposes, sold in the stores, are as a rule satisfactory. Care should be taken to see that they are of proper strength.

Oil spices, which are sometimes used, may be desirable under certain circumstances. Their effect, however, is less lasting than that of the whole spices, which are to be preferred.

Turmeric has been much used in both the commercial and household preparation of pickles. While certain of its qualities undoubtedly entitle it to be classed among the spices, it does not rank in importance as such with the others named. It is employed largely because of its supposed effect on the color of pickles. As a coloring agent its value is probably overestimated.

Dill herb (*Anethum graveolens*) is practically always used with cucumbers when they are fermented in a weak brine, and often with other vegetables fermented in this way. It gives to the pickle a distinct flavor which is very popular. The dill herb, a native of southern Europe, can be grown in nearly all parts of this country, and usually is obtainable in the markets of the larger cities. While the entire stalk of the dill herb is of value for flavoring, the seeds are best suited for imparting the desired flavor. For this reason the crop should not be harvested until the seeds are fully mature, and should be harvested before the seeds become so ripe that they fall off. The herb may be used green, dried, or brined. When green or brined dill is used, take twice the quantity by weight as would be required if the dried herb were used. Dill retains its flavor for a long time when brined. To preserve it in this way, it should be packed in a 60° brine, or if it is to be kept for a long time in an 80° brine. Dill brine is as useful as the herb for flavoring.

The salinometer, an instrument for measuring the salt strength of a brine, is very useful, though not absolutely essential, in brining. By following the directions given in this bulletin it will be possible to make up brines of the required strength without the use of this instrument. Results may be checked up readily, however, and any changes in brine strength which may occur from time to time detected by the use of the salinometer. The salinometer scale is graduated into 100 degrees which indicate the range of salt concentration between 0°, the reading for pure water at 60° F., and 100°, which indicates a saturated salt solution (26½ per cent). By reference to Table 1 (page 20), the relation between salinometer readings and salt percentages may be readily determined. Salinometers are sold by firms dealing in chemical apparatus and supplies for about \$1 each.

SALT PICKLES.

In the household, where pickles usually are made in small quantities, stone jars constitute very useful receptacles. A 4-gallon jar, which will hold approximately 12 pounds ($\frac{1}{4}$ bushel) of cucumbers, is a convenient size.

Wash the cucumbers if dirty, pack them in the jar, and cover with 6 quarts of a 10 per cent brine (40° on salinometer scale). At the time of making up the brine, or not later than the following day, add more salt at the rate of 1 pound for every 10 pounds of cucumbers used, in this case 1 pound and 3 ounces. This is necessary in order to maintain the strength of the brine. Cover with a round board or plate and on top of this place a weight heavy enough to keep the cucumbers well below the surface. At the end of one week and of each succeeding week for 5 weeks add (in this case) $\frac{1}{4}$ pound of salt. In adding salt always place it on the cover. If the salt is added directly to the brine it may sink to the bottom, as a result of which the salt solution at the bottom would be very strong, while that near the surface might be so weak that the pickles would spoil. A scum, made up usually of wild yeasts and molds, will form on the surface. As this may prove injurious by destroying the acidity of the brine, it should be removed by skimming.

Clean, water-tight barrels should be used in making larger quantities of pickles. With a barrel holding from 40 to 45 gallons, proceed as follows: Put into the barrel from 5 to 6 inches of a 40° brine (Table 1, page 20). To this brine it is well to add 1 quart of good vinegar. In this brine place the cucumbers as they are gathered. To keep the cucumbers below the brine, put a loose wooden cover over them and weight it with a stone heavy enough to bring the brine over the cover. The cucumbers should be weighed each time before

they are added. After the cover and stone have been replaced add to the brine over the cover 1 pound of salt for every 10 pounds of cucumbers added.

If the cucumbers are not added too rapidly it will be unnecessary to add more brine, for when a sufficient weight is maintained on the cover the cucumbers make their own brine. If, however, the cucumbers are added rapidly, or if the barrel be filled at once, more brine may be required. In such a case add a sufficient amount of the 10° brine to cover the cucumbers.

When the barrel is full, add 3 pounds of salt each week for 5 weeks (15 pounds to a 45-gallon barrel). In adding the salt place it on the cover. Added in this way it goes into solution slowly, insuring a brine of uniform strength throughout and a gradually increasing salt concentration. Thus shriveling of the pickles is prevented to a great extent and the growth and activity of the lactic bacteria are not seriously checked. Stirring or agitation of the brine is not advisable and may be harmful for the reason that the introduction of air bubbles is conducive to the growth of spoilage bacteria. The scum which forms from time to time on the surface should be removed.

If the cucumbers are kept well under the brine and salt is added in the proportion indicated, it will not be necessary to exclude the air or seal in any manner.

Pickles prepared in this way are known as salt pickles (or salt stock). If they are well covered by the brine and if the surface remains clean they should keep indefinitely. A proper curing requires from 6 weeks to 2 months or possibly longer, according to the temperature at which it is carried out and the size and variety of cucumbers used.

After a partial soaking in water to remove excess of salt, these cucumbers may be eaten as salt pickles. Many prefer them in this form. Most people, however, like them better after they have been given an additional treatment in vinegar alone, or in vinegar combined with sugar and spices. Whatever the final disposition, pickles should first receive this perfect curing in brine. Attempts to use short cuts or to make pickles "over night," as is sometimes advised, are based on an erroneous conception as to what really constitutes a pickle.

PROCESSING AND SORTING SALT PICKLES.

After being cured in brine, pickles must receive a processing in water to remove the excess of salt. If they are to be used as salt pickles, only a partial processing is required. If, however, they are to be made into sour, sweet, or mixed pickles, the salt should be to a great extent, though not completely, removed. Pickles keep better

when the salt is not entirely soaked out. Under factory conditions, processing is readily accomplished by placing the pickles in tanks, which are then filled with water and subjected to a current of steam, the pickles being agitated meanwhile. In but few homes, however, is the equipment for such treatment available. The best that can be done is to place the pickles in a suitable vessel, cover them with water, and heat them slowly to 120° F., at which temperature they should be held for from 10 to 12 hours, being stirred frequently. The water is then poured off, and the process repeated. It may be necessary to repeat it several times, especially if the pickles are large. The number of times can be determined by tasting the product.

After processing, the pickles should be sorted, an important step in reference to their further treatment. In order to secure the best appearing product, pickles should be as nearly as possible of uniform size. At least three sizes are recognized—small, medium, and large. If intended for bottling, only the small sizes are selected. Fairly small and medium sizes are well adapted to the making of sweet pickles. The larger sizes may be used for sour and dill pickles. Imperfectly formed pickles, the so-called crooks and nubs, can be well utilized by being cut up and added to mixed pickles or other combinations of which cucumbers form a part.

SOUR PICKLES.

After pickles have been processed sufficiently, drain them well, and cover them at once with vinegar, using a good clear vinegar¹ of 40 to 60 grain strength (4 to 6 per cent of acetic acid). If fruit vinegars are employed, they should be well filtered first, to remove all sediment. It is believed that a 40 or 45 grain vinegar gives all the sourness that is desirable. If, however, very sour pickles are preferred, it would be well to use, at first, a 40 grain vinegar, and after a week or 10 days transfer the pickles to a vinegar of the strength desired.

SWEET PICKLES.

In order to make sweet pickles, it is necessary to cover the cured and processed cucumbers with a sweet liquor, made by dissolving sugar in vinegar, with the addition usually of spices. For this purpose, a good, clear vinegar and granulated sugar are recommended. Other forms of sugar may be used but they are not as satisfactory. The amount of sugar taken depends upon the degree of sweetness desired. It may vary from 4 to 10 pounds to the gallon of vinegar, 6 pounds to the gallon usually giving satisfactory results. The chief difficulty in making sweet pickles is due to the fact that they often become shriveled and tough. This danger increases with the sugar

¹ Many pickle manufacturers prefer to use distilled vinegar, for the reason that it is colorless and free from sediment.

concentration of the liquor, and usually can be avoided by covering the pickles first with a plain 40 to 45 grain vinegar, adding the sugar 10 days later. If a liquor containing more than 4 pounds of sugar to the gallon is desired, it would be best not to exceed that amount at first, but gradually add sugar until the desired concentration is obtained. If a saccharometer is at hand this can be very readily and accurately accomplished. For this purpose use a Brix or Balling saccharometer graduated from 0° to 70°. A reading of 42° on the Balling scale would indicate a sugar concentration of approximately 6 pounds of sugar to the gallon of vinegar (Table 3, p. 21).

Spices are practically always added in making sweet pickles. These should not, however, be used in too large a quantity. The effect of too much spice, especially the stronger varieties, like peppers and cloves, is injurious rather than beneficial. One ounce of whole mixed spices to 4 gallons of pickles and a proportionate amount for a less quantity is ample. As spices may cause cloudiness of the vinegar, they should be filtered out after the desired flavor has been obtained to secure the best-appearing product. A better utilization of spice is secured by the aid of heat. Add the required amount of spice to the vinegar and hold at the boiling point for not longer than one-half hour. Heating too long causes darkening of the vinegar. Filter out the spices by pouring the mixture through cheesecloth. If considered desirable add sugar at this time and pour at once over the pickles.

In case the pickles are to be packed in bottles or jars, after such preliminary treatment as may be required, transfer them to these containers, and cover with a liquor made up as desired.

MIXED PICKLES.

For making mixed pickles various combinations of vegetables are used, depending upon the mixture desired and the available supply. In addition to cucumbers, onions, cauliflower, green peppers, tomatoes, and beans are well suited to this purpose. All vegetables which are used in making mixed pickles should first be properly cured in brine, just as in the case of cucumbers.

For making mixed pickles very small vegetables are much to be preferred. If larger ones must be used, they should first be cut into pieces of a desirable and uniform shape and size.

For containers use wide-mouthed bottles or jars. Place in the bottom of each a small amount of mixed spice. In filling the bottle arrange the various kinds of pickles in as neat and orderly a manner as possible. The appearance of the finished product depends largely upon the manner in which they are packed in the bottle. Do not fill the bottles entirely.

If sour pickles are desired, fill the bottles completely with a 40 grain vinegar. If sweet, fill with a liquor made by dissolving from 4 to 6 pounds of sugar in a gallon of vinegar.

Seal tight and label properly. If wood corks are used for sealing, they should first be dipped in hot paraffin.

DILL PICKLES.

The method for making dill pickles differs from that for making salt pickles in two important particulars: (1) A much weaker brine is used, and (2) spices are added, chief of which is dill. Dill herb, the entire stalk of which is used, gives a distinctive flavor to pickles.

By reason of the weaker salt concentration, a much more rapid curing of the pickles takes place. As a result they can be made ready for use in about half the time required for ordinary brined pickles. This shortening of the period of preparation, however, is gained at the expense of the keeping quality of the product. For this reason it is necessary to resort to measures which will prevent spoilage.

For making dill pickles in the home, use stone jars, or clean, water-tight kegs or barrels. If a 4-gallon jar is used, proceed as follows: Place in the bottom a layer of dill and $\frac{1}{2}$ ounce of mixed spice. Then fill the jar to within two or three inches of the top with washed cucumbers which are as uniform in size as possible. Add another $\frac{1}{2}$ ounce of spice and layer of dill. If they can be obtained, it is a good plan to place over the top a layer of grape leaves. In fact, it would be well to place these at both the bottom and top. They make a very suitable covering and have been found to have a greenening effect on the pickles. Pour over the pickles a brine made up as follows: Salt, 1 pound; vinegar, $\frac{3}{4}$ quart; and water, 10 quarts. Cover with a board cover or plate with sufficient weight on top to hold the cucumbers well below the brine. If the cucumbers are packed at a suitable temperature (about 86° F.), an active fermentation will at once set in. This should be completed in from 10 days to 2 weeks, if a temperature of about 86° F. is maintained. A scum soon forms on the surface. This consists usually of wild yeasts, but often contains molds and bacteria, and should be skimmed off.

After active fermentation has ceased, it is necessary to protect the pickles in some way against spoilage. This may be done in one of two ways: (1) Cover with a layer of paraffin. This should be poured while hot over the surface or as much of it as is exposed around the edges of the board cover. When cooled this forms a solid coating which effectually seals the pickles. (2) Seal the pickles in glass jars or cans. As soon as it is found that they are sufficiently cured, which

may be determined by their agreeable flavor and dark-green color, transfer them to glass jars (2-quart size), and fill with a fresh brine made as directed. Add a small amount of dill and spice. In this case it is well to bring the brine to a boil, and, after cooling slightly, pour it over the pickles. Seal the jars tight.

In this connection it may be well to call attention to the fact that in no case should a hot brine be used at the start of a fermentation. In all probability the hot brine would kill the organisms present, thus preventing any fermentation.

The plan of preserving dill pickles by sealing in jars has the merit of permitting the use of a small quantity without the necessity of opening up and again resealing a large bulk, as is the case when pickles are packed in large containers and sealed with paraffin.

If it is desired to put up dill pickles in barrel lots, select none but clean, tight barrels. Anything in the barrels which would give the pickles an "off" flavor must be removed. A careful observance of this precaution may save much trouble and disappointment.

Fill the barrel with washed cucumbers, adding from 6 to 8 pounds of green or brined dill, or half that amount of dry dill, and 1 quart of mixed spices. If brined dill is used, it is well to add about 2 quarts of the dill brine. The dill and spices should be evenly distributed at the bottom, middle, and top of the barrel. Also add 1 gallon of good vinegar.¹ Head up tight and through a hole bored in the head fill the barrel with a brine made by adding salt in the proportion of $\frac{1}{2}$ pound to the gallon of water. Add brine until it overflows the head and is level with top of the chimb. This level should be maintained by adding brine from time to time as required. Remove the scum which soon forms on the surface. During the period of active fermentation the barrel should be kept in a warm place, and the hole in the head should remain open to allow gas to escape. When active fermentation is over, as indicated by the cessation of bubbling and frothing on the surface, the barrel may be plugged up tight and placed in storage, preferably in a cool place. It is well to bear in mind, however, that, on account of leakage and other causes, the brine in a barrel of pickles may recede at any time. Occasional inspection, therefore, should be made to determine this matter, and, if necessary, more brine added. Pickles put up in this way should be ready for use within about 6 weeks.

¹ The addition of vinegar is not essential in the making of dill pickles, and many prefer not to use it. Its use, however, in the proportion indicated would be favorable to the growth of the lactic bacteria and at the same time would be inhibitive, to some extent at least, to the growth of spoilage organisms. Its use, therefore, is to be regarded with favor. Some prefer also to omit the use of mixed spices for the reason that they interfere with the distinctive flavor of the dill herb which by many is considered most desirable.

In case it is desired to hold the pickles in storage for a long time, it would be advisable to use a brine somewhat stronger than that indicated. A 30° brine, made by adding 10 ounces of salt to a gallon of water, is used for this purpose. Pickles packed in a brine of this strength will keep a year if the barrels are kept filled and in a cool place. The important factor in preserving pickles put up in a weak brine, such as is ordinarily used for dill pickles, is the exclusion of air. When put up in tight barrels this is accomplished by keeping the barrels entirely filled with brine.

SAUERKRAUT.

Fermented salt cabbage, commonly called sauerkraut, is a form of food which has much to commend it to popular favor. The making of sauerkraut offers a good means of utilizing surplus stocks of cabbage and at the same time affords a food which to most people is both palatable and wholesome. It also enables the housewife to carry over into the winter months a form of vegetable food which helps to vary the diet at a time when this often consists too largely of meat.

For making sauerkraut in the home 4- or 6-gallon stone jars constitute the best containers, unless very large quantities are desired, in which case kegs or barrels may be used.

Select only mature, sound heads of cabbage. Quarter them and slice off the core portion. For shredding, one of the hand shredding machines which can be obtained on the market is much the best, although an ordinary slaw cutter or a large knife will do.

In making sauerkraut the fermentation is carried out in a brine made from the juice of the cabbage which is extracted by the action of salt. One pound of salt for every 40 pounds of cabbage makes the proper strength of brine to produce the best results. This may be distributed as the cabbage is packed in the jar or it may be mixed with the shredded cabbage before being packed. Thus, the distribution of 2 ounces of salt with every 5 pounds of cabbage probably is the best way to secure an even distribution. The cabbage should be packed firmly but not too tightly in the jar or keg. When full, cover with a clean cloth and a board cover or plate. On the cover place a weight heavy enough to cause the brine to come up to the cover. If the jar is kept at a temperature of about 86° F., fermentation will start promptly. A scum soon forms on the surface. As it tends to destroy acidity and may injure the cabbage beneath, it should be skimmed off from time to time. If kept at the temperature indicated the fermentation should be completed in from 6 to 8 days.

A well-fermented sauerkraut should show a normal acidity of approximately +20 or a lactic acid percentage of 1.8 (p. 21).

After fermentation is complete, the kraut should be set in a cool place. If the cabbage is fermented late in the fall or if it can be stored in a very cool place, it may not be necessary to do more than keep the surface skimmed and protected from insects, etc. Otherwise, it will be necessary to resort to measures to prevent spoilage. This may be done, as suggested in the case of dill pickles, by one of two methods: (1) A layer of hot paraffin may be poured over the surface, or as much of it as is exposed around the cover. Properly applied to a clean surface, this effectually seals the jar and protects the contents from contamination. (2) After the fermentation is complete, pack the kraut in glass jars or cans, adding enough of the kraut brine, or, in lieu of this, a weak brine made by adding 1 ounce of salt to a quart of water, to completely fill the jars. Seal the jars tight, and set them away in a cool place. If it has reached the proper degree of acidity, sauerkraut preserved in this way should keep as long as desired.

FERMENTATION AND SALTING AS A MEANS OF PRESERVING VEGETABLES.

Vegetables other than cucumbers and cabbage may be preserved by means of a lactic fermentation in brine. This may be accomplished by either of the two methods already discussed, namely, fermentation in brine produced by dry salting or fermentation in an added brine.

The first method, of course, is applicable only to those vegetables which contain a sufficient amount of water to make their own brine. The best example of this is found in cabbage (p. 15). String beans, however, if young and tender, may well be preserved in this way. To do this, remove tips and strings, and, if large, break into two pieces. Use 3 per cent salt.

Many vegetables can be well fermented in an added brine. This is the only plan available for those which do not contain enough water to make their own brine. For this purpose use a brine made by adding $\frac{1}{2}$ pound of salt and $\frac{1}{2}$ pint of vinegar to a gallon of water. Dill and spices may be added, if desired. String beans, green tomatoes, beets, chayotes, peas (shelled), and corn (on cob) may be preserved in this way. To preserve vegetables successfully in this way, follow the general directions given for making dill pickles (p. 13).

Another method which may be chosen for preserving vegetables is that of dry salting without fermentation. To do this, sufficient salt must be added to prevent all bacterial action. Wash and weigh the vegetables. Then mix with them thoroughly one-fourth their weight of salt. If after the addition of pressure not enough brine to

cover the product is formed, add brine made by dissolving 1 pound of salt in 2 quarts of water. As soon as bubbling ceases, protect the surface by covering with paraffin. Corn can be well preserved in this way. It is first husked and the silk removed, after which it is cooked in boiling water for 10 minutes to set the milk. The corn is then cut from the cob with a sharp knife, weighed, and packed in layers with one-fourth its weight of fine salt. This method is especially well adapted to those vegetables in which the sugar content is too low to produce a successful fermentation, such as chard, spinach, and dandelions.

The methods of food preservation outlined are not necessarily limited to vegetables. Solid fruits, like clingstone peaches and Kieffer pears, can be preserved in an 80° brine for as long as 6 months, when, after the salt has been soaked out, they may be worked up into desirable products by the use of spices, vinegar, sugar, etc. Soft fruits, like Elberta peaches and Bartlett pears, are best preserved in a weak vinegar (2 per cent acetic acid).¹

The preservation of vegetable foods by lactic fermentation in brine and by dry salting is not to be recommended indiscriminately. Rather is this plan to be regarded in the light of an emergency measure. Experiments have shown very clearly that foods preserved by these methods lose decidedly in nutritive value as well as in natural flavor by the time they are ready for use. With the exception of the making of pickles and sauerkraut from cucumbers and cabbage, where fermentation is always to be regarded as a useful and desirable method of utilization, canning, as a rule, offers a better means of preserving both vegetables and fruits, because in this way the nutritive constituents and natural flavors of the food are more completely retained. Often, however, because of lack of time, a shortage of cans or an oversupply of a product, canning is out of the question. Under such conditions the possibilities of utilization by means of brining or salting should always be considered.

CAUSES OF FAILURE AND HOW TO AVOID THEM.

A soft or slippery condition is one of the most common forms of spoilage in making pickles. This is the result of bacterial action, and always occurs when pickles are exposed above the brine and very often when the brine is too weak to prevent the growth of spoilage organisms. Prevention lies in keeping the pickles well below the brine and the brine at the proper strength. Experiments have shown that in order to insure the keeping of pickles for more than

¹ Report of an investigation made in the Bureau of Chemistry on the utilization of brined products, by Rhea C. Scott, 1919.

a very few weeks a brine should contain 10 per cent of salt. Once pickles have become soft or slippery as a result of bacterial action, no form of treatment will restore them to a normal condition.

Hollow pickles sometimes occur during the process of curing. This is, indeed, one of the most frequent causes of failure in pickle making. This condition does not, however, mean a total loss, as in the case of softening, for the reason that such pickles may be utilized in the making of mixed pickles or certain forms of relish. Hollow pickles are generally believed to be the result of a faulty development or nutrition of the cucumber. While there are good reasons to believe that this trouble is inherent in the cucumber, there is also a strong probability that faulty methods may contribute to this condition. One of these is allowing too long a time to intervene between gathering and brining. This period should not exceed 6 or 8 hours.

Hollow pickles frequently become *floaters*. This condition is the result of the formation of gas within the pickle. This lowers the relative weight of the pickles and causes them to rise to the surface.

The use of so-called hard waters should be avoided in making up a brine. The presence of large amounts of calcium salts and possibly of other salts found in many natural waters may prevent the proper acid formation and thus interfere with a normal curing of the pickles. The addition of a small amount of vinegar serves to overcome alkalinity and is valuable, especially where hard water must be used in making up brine (p. 9). Iron, if present in any appreciable amount, is very objectionable. The presence of iron, under certain conditions, may cause a blackening of the pickles.

Shriveling of pickles often occurs when they have been placed at once in very strong salt or sugar solutions or even in very strong vinegars. For this reason such solutions are to be avoided so far as possible. When their use is desirable, the pickles should first be given a preliminary treatment in a weaker solution. This difficulty is most often encountered in the making of sweet pickles. The presence of sugar in high concentrations is certain to cause shriveling unless proper precautions are taken. These have already been discussed (p. 11).

Perhaps the most common cause of failure in making sauerkraut is the use of too much salt. A wide experience has shown that the proper amount is $2\frac{1}{2}$ per cent by weight of the cabbage packed. When cabbage is to be fermented in very warm weather, it may be expedient to use a somewhat larger percentage of salt. As a rule, however, this should not exceed 3 per cent. In applying the salt, care should be taken to see that it is evenly distributed. Red streaks which sometimes occur in sauerkraut are believed to be due to an uneven distribution of salt.

Spoilage of the top layers of vegetables fermented in brine is very sure to occur unless the scum which forms on the surface is frequently removed. This scum is made up of wild yeasts, molds, and certain bacteria, which, if allowed to remain, attack and break down the vegetables beneath. They may also weaken the acidity of the brine, in which way they are conducive to spoilage. The fact that the top layers have spoiled does not necessarily mean, however, that the entire contents of the vessel are spoiled. The molds and other organisms which cause the spoiling do not penetrate rapidly to the lower layers. The part found in good condition may commonly be saved by carefully removing the spoiled material from the top, adding a little fresh brine, and pouring hot paraffin over the surface.

Temperature has an important bearing on the success of a lactic fermentation. It has been found that the bacteria which are essential in the fermentation of vegetable foods manifest their greatest activity at a temperature of approximately 86° F., and that as the temperature falls below this point their activity correspondingly diminishes. It is essential, therefore, that at the start and during the active stages of a fermentation these foods be kept as nearly as possible at 86° F. This is especially to be kept in mind in connection with the production of sauerkraut, which is often made in the late fall or winter. As a result of too low a temperature the fermentation may be much retarded or even an entire failure.

After the active stages of a fermentation have passed, the food should be stored in a cool place. Low temperatures always are conducive to the preservation of food products.

COLORING AND HARDENING AGENTS.

In order to secure a better looking product, the practice prevails in some households of greening pickles by heating them with vinegar in a copper vessel. Experiments have shown that pickles treated in this way take up very appreciable amounts of the copper acetate thus formed. All the copper salts are more or less toxic agents. By a ruling of the Secretary of Agriculture, made July 12, 1912, foods greened with copper salts are to be regarded as adulterated, and as such are subject to action under the provisions of the Food and Drugs Act of June 30, 1906.

Alum is much used and recommended for the purpose presumably of producing a greater degree of firmness in pickles. The use of alum in connection with food products is of doubtful expediency, to say the least. If the proper methods are followed in preparing pickles, the salt and acids in the brine will produce the desired degree of firmness. The use of alum or any other hardening agent is believed to be unnecessary.

MISCELLANEOUS INFORMATION.

TABLE 1.—*Salt percentages, corresponding salinometer readings, and amount of salt required to make 6 quarts of brine.*

Salt in solution.	Salino-meter reading.	Amount of salt present in 6 quarts of finished brine.	Salt in solution.	Salino-meter reading.	Amount of salt present in 6 quarts of finished brine.
<i>Per cent.</i>	<i>Degrees.</i>	<i>Ounces.</i>	<i>Per cent.</i>	<i>Degrees.</i>	<i>Ounces.</i>
1.06	4	2	8.48	32	18
2.12	8	4 $\frac{1}{4}$	9.54	36	20
3.18	12	6 $\frac{1}{2}$	10.6	40	22 $\frac{1}{2}$
4.24	16	8 $\frac{1}{2}$	15.9	60	35 $\frac{1}{2}$
5.3	20	11	21.2	80	48
6.36	24	13	26.5	100	64
7.42	28	14 $\frac{1}{2}$			

The figures given in the first two columns of Table 1 are correctly stated. Those in the last column are correct within the possibilities of ordinary household methods. In making up a brine from this table, first dissolve the required amount of salt in a smaller volume of water, then add water to make up as nearly as possible to the required 6 quarts.

One pound of salt dissolved in 9 pints of water makes a solution with a salinometer reading of 40°, or approximately a 10 per cent brine. In a brine of this strength fermentation proceeds somewhat slowly. Pickles kept in a brine maintained at this strength will not spoil. One-half pound of salt dissolved in 9 pints of water makes approximately a 5 per cent brine with a salinometer reading of 20°. A brine of this strength permits a rapid fermentation, but vegetables kept in such a brine will spoil within a few weeks unless air is excluded.

A brine in which a fresh egg just floats is approximately a 10 per cent solution.

Fermentation takes place fairly well in brines of 40° strength, and will, to some extent at least, up to 60°. At 80° all fermentative action ceases.

The amount of brine necessary to cover vegetables is equal to about one-half of the volume of the material to be fermented. For example, if a 5-gallon keg is to be packed, 2 $\frac{1}{2}$ gallons of brine are required.

TABLE 2.—*Freezing point of brine at different salt concentrations.*

Salt.	Salino-meter reading.	Freezing temperature.
<i>Per cent.</i>	<i>Degrees.</i>	<i>° F.</i>
5	20	25.2
10	40	18.7
15	60	12.2
20	80	6.1
25	100	0.5

TABLE 3.—*Density of sugar sirup.*

Density.	Quantity of sugar for each gallon of water. ¹		Density.	Quantity of sugar for each gallon of of water. ¹	
<i>Degrees Brix or Balling.</i>	<i>Lbs.</i>	<i>Ozs.</i>	<i>Degrees Brix or Balling.</i>	<i>Lbs.</i>	<i>Ozs.</i>
5		7	35	4	7. 75
10		14. 8	40	5	8. 75
15	1	7. 5	45	6	13
20	1	14. 75	50	8	5. 25
25	2	12. 5	55	10	4
30	3	9	60	12	8

¹ When vinegar is used, the equivalent saccharometer reading would be about 2 degrees higher than that indicated in the table.

TABLE 4.—*Number of pickles of various sizes required to make a gallon.*

Size.	Variety.	Number to a gallon.
1 to 2 inches.....	Gherkins ¹	250 to 650
2 to 3 inches.....	Small pickles.....	130 to 250
3 to 4 inches.....	Medium pickles.....	40 to 130
4 inches and over.....	Large pickles.....	12 to 40

¹ Small pickles are usually designated as gherkins. Those of very small size are sometimes called midgets.

The maximum degree of acidity formed by a lactic fermentation of vegetables in brine varies from 0.25 to 1.8 per cent. The maximum acidity is reached at or soon after the close of the active stage of fermentation. After this period the amount of acid usually decreases slowly. The stage of active fermentation continues for from 1 to 3 weeks, depending upon the temperature, strength of brine, etc. During this period gas is formed, and more or less froth appears on the surface, due to the ascent of gas bubbles. At the close of this period the brine becomes "still."

The amount of acid formed depends primarily upon the sugar content of the vegetables fermented, but may be influenced by other factors. The fact that a brine has become acid may be determined by the use of litmus paper. Blue litmus paper dipped in an acid brine will become red. This does not, however, give definite information as to the degree of acidity. For those who may wish to determine accurately the degree of acidity in brines, the following method is given:

With the aid of a pipette, transfer exactly 5 cc. of the brine to a small evaporating dish. To this add 45 cc. of distilled water and 1 cc. of a 0.5 per cent solution of phenolphthalein in 50 per cent alco-

hol. Then run in slowly a 1/20 normal sodium hydrate solution. This is best done by the use of a 25 cc. burette graduated in tenths. As the sodium hydrate is being added stir constantly, and note carefully when the entire amount shows a faint pink tint. This indicates that the neutral point has been reached. Read off carefully the exact amount of sodium hydrate required to neutralize the mixture in the dish. This number multiplied by 0.09 gives the number of grams of acid per 100 cc., calculated as lactic, present in the brine.

This same method can be used to determine the acid strength of vinegars. In this case multiply by 0.06 to ascertain the number of grams of acetic acid per 100 cc. present in the vinegar.

The apparatus and chemicals needed for this test can be obtained from any firm dealing in chemical apparatus and supplies.

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